values are the determinations most frequently useful in forming a conclusion.

The chemistry of the essential oils is no doubt better and more widely known than that of the resins. Nevertheless, in the interests of readers who are not specialists in this branch of chemical work, a summary of the chief facts respecting the composition of the essentials oils may not be unprofitable. These oils, to which the characteristic odours of flowers and plants are nearly always due, are composed of some half-dozen groups of compounds, one or two of the groups predominating in any particular oil. *Terpenes* constitute the bulk of many essential oils, but are seldom the most useful portion. In fact, various so-called "terpeneless" oils are now prepared, the removal of terpenes serving in effect to concentrate the odoriferous properties of the oil in the residual constituents. *Alcohols* of various types—open-chain, aromatic, and sesquiterpene alcohols—with their corresponding *aldehydes* and *ketones*, are the important compounds in many oils. Examples are the alcohol *geraniol* in otto of rose; the aldehyde *citral* in lemon-grass oil, and the ketone *pulegone* in oil of penny-royal. Bergamot, clove, and mustard oils respectively owe their special properties to *esters*, *phenols*, and *sulphur compounds*. Methods by which the proportions of the various constituents may be determined, usually with a fair approach to accuracy, are described at length in the volume, which can be recommended as well worthy of its place in the series.

C. Simmonds.

MECHANICS, THEORETICAL AND TECHNICAL.

(1) *Lehrbuch der technischen Physik.* By Prof. Hans Lorenz. Dritter Band, Technische Hydromechanik. Pp. xxi+500. (Munich and Berlin: R. Oldenbourg, 1910.) Price 14 marks.

(2) *Die Theorie der Kräftepläne.* By Prof. H. E. Timerding. Pp. iv+100. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 2.50 marks.

(3) *Vibrations of Systems having One Degree of Freedom.* By Prof. B. Hopkinson. (Cambridge Engineering Tracts, No. 1.) Pp. 54. (Cambridge: University Press, 1910.) Price 2s. 6*d*. net.

(4) *Leerboek der Werktuigkunde.* By F. J. Vaes. Vol. i., pp. xii+152. Vol. ii., pp. xiv+224. (Schiedam: H. A. M. Roelants, 1910.) Price 1.40 gulden.

THERE is probably no branch of science in which such wide gaps occur between theory and practice as in the study of the motion of fluids. We have, on one hand, the mathematical theory of hydrodynamics, which is limited by the difficulty of obtaining soluble problems and building up integrals of the differential equations of motion subject to given boundary conditions. This difficulty alone restricts the scope of the investigation mainly to the study of perfect fluids, thus immediately introducing a discrepancy between theory and observation. On the other hand, we have the hydraulics of the engineering student, the object of which is mainly to enable numerical calculations to be made regarding such problems as town water supply, efficiency of turbines, pumps, propellers, and ships.

In endeavouring to produce a text-book on technical hydromechanics (1) which should be satisfactory both from a theoretical and from a technical point of view, Prof. Lorenz thus undertook a duty of enormous difficulty. It is not surprising that when he had half finished the manuscript in 1906 he was so dissatisfied with the result that he decided to start afresh, a task which he did not commence until 1908, after re-studying the subject and making a number of original investigations. That such difficulties would exist was shown not only by what he describes as the "step-motherly" treatment of this subject in technical colleges, but also by the absence of any comprehensive treatise covering the required ground. Books on hydraulics generally treated the subject entirely from Bernouilli's principle, combined with the hypothesis of parallel sections, nothing being said about Euler's equations of motion in three dimensions, much less of their modifications for viscous fluids. In one case the treatment of hydraulics was preceded by an introduction on hydrodynamics, an order of treatment likely to confuse rather than enlighten the "applied science" student. On the other hand, we have purely theoretical treatises on hydrodynamics, where practical applications are represented only by half a chapter on the hypothesis of parallel sections, and this Cambridge lecturers, at any rate formerly, told their students to omit.

The order of treatment adopted by Prof. Lorenz is probably the best that could be devised for the object in view. Starting with analytical hydrostatics (including the oscillations of floating bodies, and surface tension) the author next deals with steady, and subsequently with variable, one dimensional motion treated by the hypothesis of parallel sections. These chapters constitute hydraulics proper, and contain applications to flow over weirs and through sluices, pumps, efficiency of turbines, and propellers, long waves in canals, and tides. The extension of the investigation to three dimensional motion leads up quite naturally to Euler's equations of motion of a perfect fluid, problems in irrotational motion, both continuous and discontinuous, vortex motion, and viscosity. In addition to such problems as are commonly treated in hydrodynamics, we have discussions of the oscillations of ships, including a digression on the Schlick gyroscope, approximate theories of the turbine, and of the resistance of ships, and the equations of motion of underground waters. The latter subject might with advantage be brought more prominently than it has been before mathematical students in this country. It affords excellent examples of motion derived from a potential, and the divergence between theory and observation is probably less than in Eulerian irrotational motion. Not the least important feature is a concluding chapter on the history of hydrodynamics. A few points in the book might be improved. The proof of the permanence of irrotational motion on p. 342 scarcely appears conclusive. The equation shows that if the components of spin are ever zero their rates of change will also be zero. This does not

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prove *without further investigation* (*e.g.* by Stokes's method) that if the components are zero initially they always will remain zero, for a similar argument applied to uniformly accelerated motion from rest would lead to a *reductio ad absurdum.* Does not the author, however, assume this inference? Again, in dealing with flow of a viscous liquid between two parallel plates, would it not be more correct to say that Hele-Shaw first made the experiments, and Stokes subsequently showed that the results were largely due to viscosity, although it was previously thought, and perhaps even incorrectly stated, that these motions represented an actual realisation of two-dimensional flow of perfect liquids?

(2) Prof. Timerding's introduction to "Graphical Statics" contains a praiseworthy attempt to bridge over the gap which so often exists between treatises of a purely theoretical character, and text-books dealing too exclusively with technical applications. In particular the author shows clearly the equivalence which exists between the equations of equilibrium of uniplanar analytical statics and the geometrical constructions of force diagrams, funicular polygons, and stress diagrams of loaded frameworks, such as roof trusses. It is not surprising to find the author compelled to limit the scope of his book to the simplest portions of the subject. By this means he rightly claims to have produced a handbook which is accessible to students possessing a limited knowledge of mathematics (including very elementary analytical geometry but excluding calculus), but which constitutes a self-contained and connected exposition of the subject-matter of which it treats. As the author points out, the book should show to the technical worker that he can derive help and elucidation even from apparently abstract theories, while, on the other side, the mathematician will see with pleasure how densely the path of practice is strewn with the finest flowers of theory.

(3) "Vibrations of Systems having One Degree of Freedom" is a tract of a rather more elementary character than the series of "Cambridge Mathematical Tracts" which have proved so useful already. It might afford a useful supplement to existing text-books for such students of physics as have attended a suitable course of preparation in the elements of the calculus and differential equations. The equations of free and forced oscillation with one coordinate are discussed, and are applied to such problems as the rolling of ships and its measurement by the pendulum. The main difficulty is for students to find time to read such tracts when they have so much other subject-matter to study; this difficulty can probably be overcome by placing the book in the hands of the lecturer rather than of the pupil. There is certainly much to be said for requiring students to get a clear understanding of vibrations with one degree of freedom before introducing them to the more general problem where there are several coordinates. So much for the use of the book by students of pure science. As for its use for the class of students for which it appears to be primarily intended, we can only express the opinion that the book tends in exactly the same direction as the two German works above reviewed, and we hope it will be as successful as they are in making such students appreciate the value of theoretical knowledge.

(4) "Leerboek der Werktuigkunde" (=Lehrbuch der Werkzeugkunde) is a text-book on elementary statics and dynamics treated without the calculus for use in the Dutch higher schools, and by private students. Both in the methods of treatment and exposition, and in the worked-out exercises, examples and questions for examination, this book closely resembles our numerous English school books on elementary mechanics. Its contents include uniformly accelerated motion, component and resultant velocities, relations between force, mass and acceleration, composition of coplanar forces and couples, centres of gravity, ordinary examples on equilibrium of bodies resting against one another, the principle of work, circular and harmonic motion, elementary moments of inertia, impact, and the so-called mechanical powers. This course of study is so familiar to English readers that further description is unnecessary. It may be noticed that while the familiar "first and second systems of pulleys" appear in the last-named section, allowance is made for passive resistances, such as friction, which is not always done in English books. On the other hand, the author still follows old customs in trying to deal with composition of velocities without the necessary explicit references to relative velocity, which last receives somewhat meagre attention, a plan which experience shows to lead to frequent mistakes on the part of students.

G. H. B.

OUR BOOK SHELF.

History of Biology. By Dr. L. C. Miall, F.R.S. (The History of Science Series.) Pp. vii+151. (London: Watts and Co., 1911.) Price 1*s.* net.

This is a wise and instructive book, such as we have learned to expect from Prof. Miall. It is scholarly but restrained, so that the reader is not overwhelmed with too much learning. It is a model of terseness, yet it has that picturesqueness of illustration which is necessary if a history is to grip the ordinary mind. A book like this, which commands our warmest admiration, could not have been written except by one who had studied the history of biology for a long time, and at first hand.

After a brief reference to the biology of the ancients, the long cessation of scientific inquiry that followed, and the revival of knowledge, Dr. Miall sketches the history in five periods. The first (1530–1660) saw the fresh start of botany and zoology, the beginning of experimental physiology, the exploration of new lands. The second (1661–1740) was the period of the early microscopists, of discussions as to the meaning of fossils, of early comparative anatomy and taxonomy, and of inquiry into the sexes of flowers. The third (1741–1789) was the time of Linnæus and the Jussieus, of Réaumur, of the rise of the genetic or historical method as illustrated by the works of Montesquieu and Buffon, of inquiries into animal intelligence and instinct, the metamorphoses of plants, the function of the green leaf, and so on. The fourth period (1790–1858) is illustrated by Sprengel and the fertilisation of flowers, by Cuvier and palæontology, by Chamisso and alternation of generations, by von Baer and embryology, by the cell-theory, and by the investigation of

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